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EFFECTS OF CALORIC LEVEL ON RUMINATING

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A series of recent studies has shown that a number of dietary variables affect ruminative behavior in institutionalized retarded persons. This experiment extends an earlier study that examined the influence of the caloric level of the diet on the frequency of ruminating. Subjects consumed regular portions of food that varied between phases from normal to high caloric levels. The data show a clear but modest inverse relation between the caloric value of the diet and the rates of postmeal ruminating.

DESCRIPTORS: rumination, diet, caloric density, feeding, mentally retarded

Ruminating, or the chronic regurgitation, chewing, and reswallowing of previously ingested food, is a potentially serious behavior that occurs in approximately 8% to 10% of institutionalized persons with mental retardation (Rast, Johnston, Drum, & Conrin, 1981). The literature on rumination in the fields of retardation, nutrition, and medicine primarily focuses on treatment rather than explanation. This literature contains speculations about the causes of this disorder, ranging from psychodynamic to medical to behavioral (e.g., Davis & Cuvo, 1980; Holvoet, 1982; Richmond, Eddy, & Greene, 1958). However, there has been no experimental investigation of its etiology, thus limiting the efficacy of treatment alternatives.

The present study is part of a systematic investigation of some of the variables that influence ruminative behavior in institutionalized individuals with mental retardation. Following pilot work, the original experiment in this series manipulated the quantity of food consumed at meals and found that satiation quantities of food greatly decreased rates of postmeal ruminating (Rast et al., 1981). However, because a satiation diet alters multiple dietary variables, the question remained as to which variables contributed to its effect (e.g., calories, stomach distention, esophageal or oropharyngeal stimulation).

Subsequent research (Johnston et al., 1990; Rast, Ellinger-Allen, & Johnston, 1985; Rast, Johnston, & Drum, 1984; Rast, Johnston, Ellinger-Allen, & Drum, 1985; Rast, Johnston, Lubin, & Ellinger-Allen, 1988a, 1988b) focused on dietary variables, although the results sometimes involved conditioning processes. Some findings of these experiments showed that (a) increased stomach distention, produced by supplementing a normal diet with wheat bran, had a small but consistent inverse relation with the amount of postmeal ruminating; (b) increased oropharyngeal stimulation from chewing showed modest but consistent decreases in ruminating; (c) pureed consistency produced more ruminating than the same food served in normal consistency; and (d) increased esophageal stimulation from swallowing supplementary liquids produced moderate decreases in ruminating.

One additional variable identified as having some influence on the rates of postmeal ruminating is the caloric density of the diet (Rast, Johnston, Ellinger-Allen, & Drum, 1985). This study showed that increasing 1 subject's caloric intake from single-portion calories to the level associated with satiation quantities decreased ruminating. Although caloric

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density in this study had a consistent inverse relation with ruminating, the effect was clearly smaller than that produced by variations in food quantity. The present experiment was designed to investigate further the role of caloric level in ruminative behavior by reproducing the effect with additional subjects.

METHOD

Subjects

Three mentally retarded individuals residing in a state institutional facility served as subjects. All 3 subjects were recommended for treatment by their program teams as exhibiting levels of rumination that interfered with their habilitation and social acceptibility. Doris was a 30-year-old nonverbal female who was profoundly retarded (according to scores on both the AAMD Adaptive Behavior Scale and the Slosson Intelligence Test). Bill was a 44-year-old male with a severe/profound level of retardation who exhibited some language (AAMD Adaptive Behavior Scale and the Stanford-Binet). James was a 40-year-old male who was severely/profoundly retarded and who had fair receptive and expressive language (AAMD Adaptive Behavior Scale and the Slosson Intelligence Test). The subjects were self-feeders and were within their normal weight range when the study began, although Bill had been losing weight in recent months. None of the subjects had received previous medical, dietary, or behavioral treatment for their ruminating, although, according to staff, all had ruminated for some years.

Setting

This study was conducted in a classroom (4.5 m by 6.5 m) serving as the research environment. Each subject ate lunch and dinner in this room at a table (3 m by 3 m) separated from other tables by partitions on each side. One to 3 other subjects and up to four research staff were also present. Immediately following meals, each subject sat in a nearby chair in the same room during the observation period. Thus, although the study was conducted in a research setting, its social characteristics were generally similar to those of a cottage or cafeteria environment.

Measurement

An observer monitored and assisted each subject during meals, insuring that he or she consumed the scheduled amount of food in an appropriate manner. Consuming the scheduled amount of food was not problematic, because typical baseline amounts of food were used in both conditions. Immediately after meals, the observer assisted the subject with toileting. Then, during the postmeal period, the observer stood or sat within 2 to 3 m of the subject and counted each ruminating response. The observation period typically began 1 to 3 min after the meal and lasted for 45 min, unless there were no ruminations in the first 20 min, at which point observation was ended. Initial observations with these subjects, as well as extensive experience with other individuals during a 10-year research program, had established that if they did not ruminate at all within the first 20 min, they were extremely unlikely to ruminate later in that postmeal period. The 45-min postmeal observation period was chosen to represent clearly the local or true rate of rumination for each subject, because none of the subjects continued to ruminate throughout the day.

A response cycle consisted of the subject bringing previously consumed food into his or her mouth from the esophagus and stomach and reswallowing it. The topography of responses varied somewhat across individuals, but was consistent within each individual. Generally a chain of discrete responses could be observed, including arching of the neck, head rolling, reverse sucking, rocking, movements of the abdomen or chest muscles, expansion of the cheeks, chewing movements, thrusting movements of the lips, observable presence of food or liquid in the mouth, swallowing, and drooling. Each subject was observed for 1 to 2 weeks prior to the onset of baseline or experimental conditions so that the ruminating response could be individually defined. A response rate was calculated for each session.

Observers were not blind to experimental conditions, both because it was not feasible, given the necessity of their involvement in managing each subject's eating behavior, and because it was not necessary (see below). Extensive previous experience with this population and disorder has shown that once subjects acclimate to the general circumstances of the research environment (which usually takes less than a week), the frequency of their ruminating does not seem to be influenced by the presence or activities of research staff. Thus, measurement reactivity due to the presence of staff was not considered to be a factor that could differentially affect responding under different phases.

Observers were given considerable training in counting ruminations, including observation and practice counting in conjunction with a trained observer. In addition, a calibration procedure was used in which each subject was videotaped a number of times under each condition while being observed by different observers. These tapes were then scored independently by an experimentally blind staff member, who could use the videotape machine's capabilities (i.e., rewind, stop action, etc.) to minimize the chances of error (Johnston & Pennypacker, 1980). Percentage accuracy for each observation was calculated by dividing the total number of ruminations counted by the observer by the total number counted by the videotape scorer. If the correspondence between the two counts was less than 90%, remedial action was taken with the observer. Mean accuracy across phases for Doris, Bill, and James, respectively, was 95%, 93.7%, and 86.5%.

Experimental Procedures

Experimental sessions were conducted weekdays at lunch (from 11:30 a.m. to 1:30 p.m.) and dinner (from 4:30 p.m. to 6:30 p.m.). At all other meals (which were consumed in their home cottages or in the cafeteria), the subjects received the usual single-portion diet. All experimental meals were composed of the normal institutional diet except for the deviations required to manipulate caloric density described below. The research staff weighed the trays and adjusted the quantity of food as necessary to insure that the quantities served satisfied the experimental protocol. The weight for all meals was held constant at 567 to 794 g.

All subjects were exposed to an ABABA sequence of phases of single-portion meals having either the caloric density characteristic of a normal institutional diet (approximately 750 to 900 calories per meal) or a caloric density matched for each subject to the median quantity of food that each had consumed during an earlier satiation phase (in which each subject consumed as much of the normal diet as he or she could at any one meal). The mean caloric level of meals consumed during high calorie phases ranged from 2,000 to 2,200 for Doris and 2,800 to 3,000 for Bill and James. In all high-calorie phases, the caloric density of meals was increased over normal levels by adding increased amounts of oils, sugars, and Polycose, a calorie supplement in the form of a tasteless powder that was mixed with the food. These calorie supplements were added to each high-calorie meal in approximately equal proportions, although some variation was necessary due to the initial calorie level of the meal. These particular supplements were chosen because they were able to increase caloric density to the required level without significantly increasing weight or reducing the palatability of the food. A registered dietician supervised all dietary aspects of the procedures.

During one portion of the treatment phase, each subject was fed a high-calorie breakfast in addition to the high-calorie lunch and dinner. During this subphase, subjects ate approximately 1,200 to 1,400 calories during breakfast, rather than the approximately 700 calories consumed during a normal breakfast. Breakfast calories were increased to replicate the interaction effect consistently found between adjacent meals, and thus to demonstrate more clearly the calorie effect at lunch (see Rast et al., 1984). This procedural variation was used during the last half of the second treatment phase for Doris and Bill and during the last half of the first treatment phase for James and is indicated by a horizontal bar on the graphs. No consistent effects were correlated with this subphase, and it will not be discussed further.

RESULTS

A comparison of individual means for each condition demonstrated an inverse relationship between caloric density and number of ruminations per minute. For each subject, mean frequency of ruminating under baseline or low-calorie conditions was slightly greater than under high-calorie conditions. The means were as follows: Doris, baseline = 0.52, high calorie = 0.38; Bill, baseline = 1.85, high calorie = 1.06; James, baseline = 0.98, high calorie = 0.83. Although the mean differences are not great, it is important to consider them in the clinical context. For instance, in Doris' data, a change in responding from 0.52 to 0.38 ruminations per minute represents a reduction of 27% from baseline to the high-calorie condition. Bill's mean rate of ruminating decreased 43%, and James showed a 15% reduction.

The data in Figure 1 are plotted on a semilogarithmic chart in terms of the frequency of ruminating after lunch and dinner meals for all subjects. These data are plotted on successive calender days, each point representing the mean number of ruminating responses per minute for a single session.

The data for Doris and Bill (Figure 1) show that the high-calorie phases corresponded to decreased levels of ruminating compared to the baseline or low-calorie phases. For all subjects, the size of the decrease under high-calorie conditions was moderate compared to the substantial and usually immediate decrease consistently associated with satiation size meals (e.g., Rast et al., 1984; Rast, Johnston, Ellinger-Allen, & Drum, 1985). The change in rates of ruminating for Doris and Bill generally took the form of an increased number of days at lower rates or zero rates under the high-calorie conditions, even though the remaining days were similar to the higher baseline levels. In other words, although some meals under high-calorie conditions were followed by the usual baseline rates of ruminating, an overall decrease in ruminating was shown in the form of an increased number of days of lower rates or days with no ruminating.

The data also show that the decrease following dinner was somewhat greater than after lunch. This interaction effect between adjacent meals was first identified by Rast et al. (1984) and has been consistently observed in other studies (e.g., Rast, Johnston, Ellinger-Allen, & Drum, 1985). In general, this relationship means that an experimental variable manipulated at breakfast or lunch will tend to have a stronger effect on ruminating after the following lunch or dinner, respectively, than after the first meal.

James' data require additional information to interpret. Figure 1 presents his rates of ruminating under a sequence of conditions similar to those of Doris and Bill. Visual examination of the data shows fewer low-rate postmeal sessions under high-calorie than under low-calorie conditions. The weaker effect shown by this subject may be related to differences in level of satiation. An initial baseline-satiation-baseline series of conditions showed that this subject did not decrease his rates of ruminating to the substantially lower levels almost uniformly characteristic of all subjects participating in this research program to date (e.g., the data in Rast et al., 1981, 1984; Rast, Johnston, Ellinger-Allen, & Drum, 1985). It is likely that this subject did not eat enough food to become satiated to the same degree as the other subjects. Thus, it was not possible to calculate a high caloric level representing the same functional level obtained from the satiation condition of the other subjects.

A further consideration stems from the consistent observation (e.g., Rast, Johnston, Ellinger-Allen, & Drum, 1985) that small increases in food quantity correspond to slight increases in ruminating, although further increases in food consumed lead to decreased rates of ruminating. Although it is not known whether this relation also holds for the component variables that covary with changes in food quantity, it might help explain the decrease in the number of low-rate sessions in the high-calorie phases. In summary, it may not be appropriate to interpret the data from James as representing the

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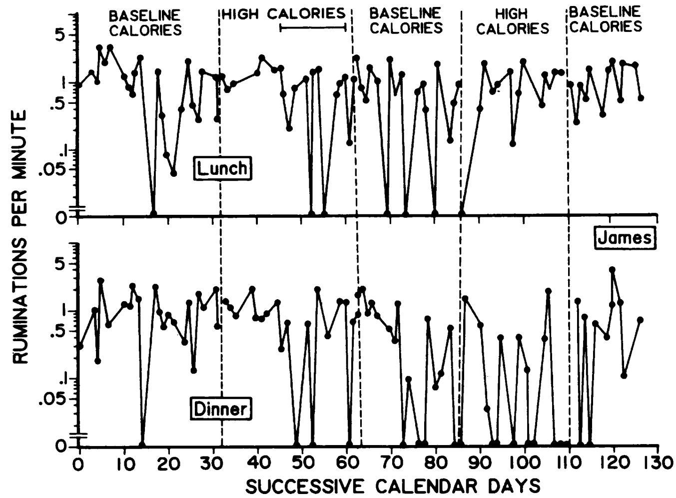
Figure 1. Rates of ruminating for Doris (top graphs), Bill (middle graphs), and James (bottom graphs) after baseline and high-calorie lunch (upper graph of each pair) and dinner (lower graph of each pair) across successive calendar days. The horizontal bar during one treatment period per subject indicates a procedural variation (see text).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RUMINATIONS PER MINUTE
Lunch
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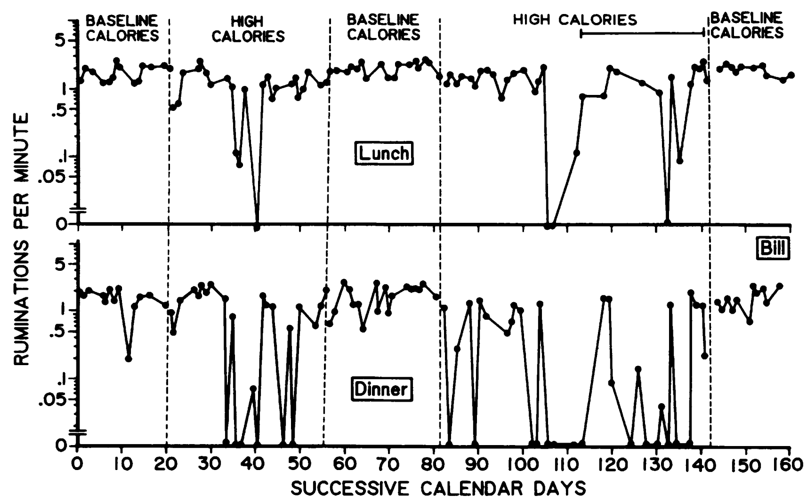
SUCCESSIVE CALENDAR DAYS


BASELINE CALORIES
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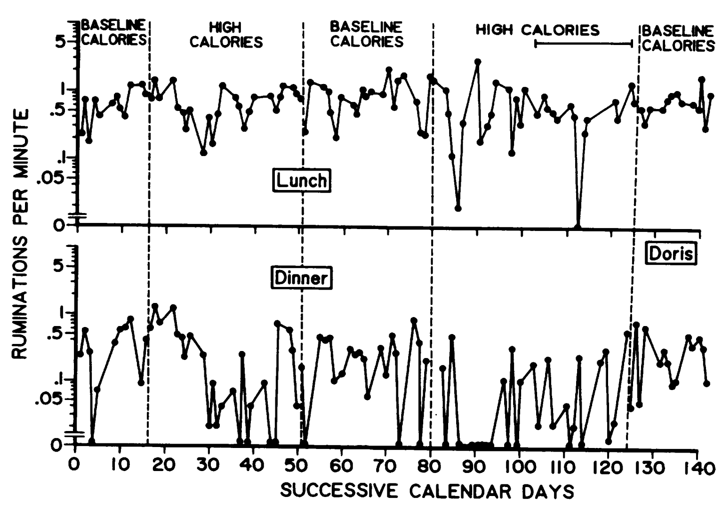
SUCCESSIVE CALENDAR DAYS


BASELINE CALORIES
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SUCCESSIVE CALENDAR DAYS

same set of conditions as those of the other 2 subjects.

DISCUSSION

The results of this experiment appear to reproduce the functional relation observed in Rast, Johnston, Ellinger-Allen, and Drum (1985). This relation suggests that the caloric level of the diet of mentally retarded individuals with long histories of ruminating is inversely related to the postmeal rate of ruminating. Unlike the relatively immediate decelerative effect on ruminating of satiation quantities of food (often observed in the first or second postmeal period in a satiation phase), the effects of consuming single-portion high-calorie meals seem to develop somewhat more gradually over a number of successive meals. This finding is consistent with that observed with other variables (Rast, Johnston, Ellinger-Allen, & Drum, 1985) and may be relevant to understanding the mechanism for the effect of calorie level on ruminating (which is unclear).

Although the size of the effect resulting from increasing caloric intake at meals is not large compared to the effect of manipulating caloric level together with other variables (e.g., stomach distention and oropharyngeal and esophageal stimulation) through variations in total food quantity consumed, it is nevertheless an effect that may have some clinical utility. For example, assuming that subjects ruminated for approximately 1 hr following each meal, the mean daily decrease in ruminations under high-calorie conditions ranged from 25.2 (Doris) to 27.0 (James) to 142.2 (Bill). These effects may be an underestimate, depending on the length of postmeal rumination and daily variability. Given the potential life-threatening nature of rumination (e.g., aspiration of regurgitated food), even a modest decrease in frequency can be justified as an important goal.

However, the major value of this effect of calorie level on rates of ruminating seems limited to its contribution to treatment programs that manipulate multiple variables simultaneously. As with some of the other factors studied in this research program, the effects of caloric level on ruminating are sufficiently modest that, used alone, they would probably constitute a clinically useful impact with only a few individuals. However, when the effect of caloric level is combined with that of other treatment variables, the accumulated impact on ruminating may be sufficient to treat this disorder effectively. For instance, the evidence from other studies in this research program (e.g., Rast, Johnston, Ellinger-Allen, & Drum, 1985) indicates that the more clinically useful effect of satiation quantities of food is partly due to the contribution of the associated increase in calories. However, for a limited number of subjects who present eating difficulties, encouraging them to consume satiation quantities of food may be unsuccessful, in which case consuming normal amounts of food of a higher caloric density may be a useful option. Of course, any treatment regimen that combines increased calories with other procedures will generate increases in body weight. However, such weight increases may be desired in the initial stages of treatment for severely malnourished and underweight clients. For those clients who are overweight, other treatment options should be considered, including the use of a low-calorie satiation diet. Finally, it is important that (a) any treatment of rumination be preceded by a medical examination to rule out certain physical anomalies that can cause this disorder and (b) a dietitian be involved in planning all dietary manipulations.

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